Vascular access for hemodialysis in the elderly

Nicola Swindlehurst, MBBS, Andrew Swindlehurst, MBBS, Heather Lumgair, MBBS, Irene Rebollo Mesa, PhD, Nizam Mamode, MB, FRCS, Roberto Cacciola, MBBS, MD, FRCS, and Iain Macdougall, MBChB, MD, FRCP, *London, United Kingdom*

Objective: **The number of elderly patients needing hemodialysis is constantly increasing year by year. Elderly patients with end-stage renal failure represent a challenge for the surgeons who create vascular accesses. The aim of this study was to analyze the outcome of conduit creation in the elderly in our institution and to compare it with the outcome of a cohort of patients aged <65 years.**

Methods: **The study was performed retrospectively on prospectively collected data. The study period was between January 1, 2000, and December 31, 2006. We identified first attempts at conduit creations, including arteriovenous fistulas (AVFs) and grafts, in elderly patients (aged ≥65 years) who were allocated to group A, and in nonelderly patients (<65 years) who were allocated to group B. Subsequent attempts at conduit creations in the same patient were omitted from the data set.**

Results: **There were 246 first AVFs in group A and 89 in group B. At a mean follow-up of 25.46 months (SD, 18.93 months), the primary patency (PP) rate of all AVFs was 70% in group A and 68% in group B ($P = .75$). The assisted PP rate was 73% in group A and 77% in group B ($P = .4$). The secondary patency (SP) rate was 73% in group A and 79% in group B ($P = .9$). Also, the differences in the 12-month cumulative patency rates (including PP, assisted PP, and SP) in the two groups (65% vs 60%) were not significant. At a mean follow-up of 25 months, death with a functioning conduit occurred at the same rate in both groups (56% and 54%), and mean conduit survival did not differ according to age (516 and 511 days). The incidence of failure to mature was higher in group A (6.1% vs 1.1%, $P = .03$). Patency rates for different types of conduits were similar between the two groups, although polytetrafluoroethylene grafts had a higher cumulative patency in group A (94% vs 69%; $P = .05$). The rate of procedures to salvage conduits was 2.5% in group A vs 10.1% in group B. Mean hospital stay for group A and group B was 3.2 days.**

Conclusions: **In our experience, the creation of permanent hemodialysis access in the elderly with AVF is not only possible but also proved to have a short hospital stay, high patency rates, and an acceptable rate of further intervention. (J Vasc Surg 2011;53:1039-43.)**

Over the years, the percentage of elderly patients requiring hemodialysis (HD) has constantly and dramatically increased. This has been shown in several published series, and now >50% of all patients starting HD are aged ≥60 years.[1,2] Originally, HD was a type of renal replacement therapy reserved for younger and fitter individuals. Improved facilities and more tolerable HD regimens have made it possible for older patients to receive HD.

Elderly patients with end-stage renal failure represent a particular challenge because of the increased prevalence of comorbidities, such as diabetes, that may lead to increased vascular pathology and greater perioperative risk. In addition, elderly patients are likely to have undergone numerous procedures requiring venipuncture throughout their lifetime, leading to increased risk of stenosis and subsequent failure after arteriovenous fistula (AVF) creation.[3-6] Late presentation and subsequent late referral for AVF creation also contribute to an increased risk of failure in these patients. Cofactors associated with the highest risk of failure include the combination of nonwhite ethnicity, diabetes, and female gender.[4]

A limited body of evidence on the outcome of AVF in the elderly has been available in the literature; the results are conflicting, and many series are now dated. There is also minimal guidance from the National Kidney Foundation Kidney Disease Outcomes Quality Initiative and the European vascular access guidelines regarding the elderly and their different medical and surgical implications.

The aim of this study was to analyze the outcome of AVF creation in the elderly in our institution and to compare it with the outcome of a cohort of patients aged <65 years.

METHODS

In this study, we analyzed all conduits constructed for hemodialysis access performed at King's College Hospital between January 1, 2000, and December 31, 2006. First-time AVFs and grafts, but not catheter placement, were included in the study. The analysis was performed retrospectively on prospectively collected data.

Before the conduit was created, the patients were assessed by the surgeon, and preoperative duplex ultrasound imaging was performed selectively when it was not possible to identify suitable veins clinically or when the clinical examination suggested possible impaired arterial inflow. A vein was considered suitable for use where duplex imaging

From the Department of Transplant Surgery, Guy's and St Thomas' NHS Foundation Trust.

Competition of interest: none.

Correspondence: Dr Nicola Swindlehurst, Kent and Sussex Hospital, Mount Ephraim, Tunbridge Wells, Kent TN4 8AT, United Kingdom (e-mail: nicola.swindlehurst@doctors.org.uk).

The editors and reviewers of this article have no relevant financial relationships to disclose per the JVS policy that requires reviewers to decline review of any manuscript for which they may have a competition of interest.

0741-5214/$36.00

doi:10.1016/j.jvs.2010.09.068

showed a consistent diameter of at least 2 mm. Our approach in the elderly is similar to younger patients: we favor the creation of distal conduit in the nondominant limb first. Also, we aim to create the conduit preemptively, so that when possible the patient will be able to start HD through an autogenous fistula.

The decision about whether a radiocephalic, brachiocephalic, brachiobasilic, or prosthetic access was formed was taken following the current Vascular Access Society Guidelines and was based on vein size, the presence of collaterals, and medical history. Venography was performed when duplex imaging or the clinical examination suggested the presence of a proximal venous stenosis, and (rarely) arteriography was performed when a proximal arterial stenosis was suspected.

We identified all patients aged ≥65 years when their first conduit was created and allocated them to group A. We also identified as a comparison group a cohort of patients aged <65 years and allocated them to group B. Patients may have received more than one conduit during the study period, but only the first conduit was considered. The comparison group included 100 randomly selected conduit creations in patients aged <65 years; the comparison group then fell to 89 when duplicate conduit attempts on the same patient were omitted from the data set.

The primary outcome measures were primary patency (PP), assisted primary patency (APP), and secondary patency (SP), as defined by Sidawy et al.[7] A secondary end point was the rate of interventions in the two groups, defined as surgical revision, thrombectomy, and angioplasty. Failure to mature means that the conduit is patent, but the flow is insufficient for adequate dialysis. A conduit was deemed successful if it was used for dialysis.

Continuous data were analyzed using the *t* test, and dichotomous data were analyzed with the χ^2 test. The Kaplan-Meier method and log-rank test were used to evaluate time-to-event distribution.

RESULTS

There were 246 conduits in group A (≥65 years) and 89 in group B (<65 years). All patient characteristics are summarized in Table I. Sex distribution was similar in the two groups. White ethnicity and diabetes were more common in group A. A higher number of patients in group A had undergone conduit creation before they needed HD. The mean follow-up period was 25.46 months (SD, 18.93 months). The anatomic site of the conduits showed statistically nonsignificant differences in the two groups.

There was no difference in hospital stay in the two groups (Table I).

All primary outcome measures showed no significant differences in the two groups. At a mean follow-up of 25 months, the PP rate of all conduits was 70% in group A and 68% in group B ($P = .75$). The APP rate was 73% in group A and 77% in group B ($P = .4$). The SP rate was 73% in group A and in 79% group B ($P = .9$). Similarly, when we evaluated the 12-month patency rates, there were no significant differences in the two groups (Table II).

Table I. Patient and conduit characteristics

Variable	*Group A (≥65)*	*Group B (<65)*	P
Total No.	246	89	
Age, years			
Mean (SD)	74 (5.7)	49 (10.4)	
Range	62-89	22-64	
Male, No. (%)	153 (62.2)	49 (55)	.2
Follow-up, mean (SD) mon	24.59 (17.81)	27.87 (21.65)	.16
Ethnicity, No. (%)			
Caucasian	154 (62)	42 (47)	.01
Black	53 (21)	32 (36)	.007
Asian	19 (7)	5 (6)	
Chinese	3 (1)	1 (1)	
Unrecorded	17 (7)	9 (10)	
Diabetes, No. (%)	102 (41)	26 (29)	.04
Hemodialysis, [a] No. (%)	114 (46)	57 (64)	.004
Type of conduit, No. (%)			
Radiocephalic	69 (27)	22 (26)	.5
Brachiocephalic	142 (58)	42 (47)	.08
Brachiobasilic	25 (11)	12 (13)	.4
Prosthetic[b]	10 (4)	13 (14)	.05
Hospital stay, mean days	3.2	3.2	

[a]Receiving hemodialysis at time of arteriovenous fistula creation.
[b]Including brachioaxillary and looped forearm access.

Table II. Patency rate (%) for all conduits at 12 months

Group	*PP (%)*	*APP (%)*	*SP (%)*
Group A (≥65)	63	65	65
Group B (<65)	54	61	61

APP, Assisted primary patency; *PP,* primary patency; *SP,* secondary patency.

Table III. Causes of primary nonfunction

Causes	*Group A (≥65) No. (%)*	*Group B (<65) No. (%)*	P[a]
Occlusion/thrombosis[b]	32 (13)	8 (8.9)	.2
Stenosis	11 (4.4)	7 (7.8)	.2
Immediate failure[c]	8 (3.2)	10 (11.2)	.002
Failed to mature	15 (6.1)	1 (1.1)	.03
Other	6 (2.4)	1 (1.1)	.4

[a]Values of $P > .05$ are not significant.
[b]Arteriovenous fistula failed >24 hours of creation.
[c]Arteriovenous fistula failed <24 hours of creation.

We also analyzed the outcome at 12 months of a subgroup of 100 patients aged >75 years. The PP rate was 77%, the APP rate was 78%, and the SP rate was 79%.

The causes of primary failure showed a similar incidence of thrombosis and stenosis in the two groups; however, there was increased failure immediately postoperatively in group B (although the numbers were small) and more failure to mature in group A (Table III).

A total of 63 procedures were performed to treat primary failure, defined as loss of PP (32 in group A and 31 in group B). Details are summarized in Table IV. Of these, 15

Table IV. Procedure to treat arteriovenous fistula failure

Procedure	*Group A (≥65)*	*Group B (<65)*	P
Fistuloplasty	26	16	.09
Thrombectomy	15	8	.34
Surgical revision[a]	11	7	.27
Total	52	31	.01

[a]Includes repeat anastomosis, transposition/superficialization, and ligation of tributaries.

Table V. Cumulative patency by type of arteriovenous fistula (*AVF*)

Type of AVF	*Group A (>65) (%)*	*Group B (<65) (%)*	P[a]
Radiocephalic	62	68	.6
Brachiocephalic	76	88	.09
BB vein transposition	80	83	.8
PTFE	94	69	.05

BB, Brachiobasilic vein transposition; *PTFE,* polytetrafluoroethylene
[a]Values of $P > .05$ are not significant.

(29%) have been successful. The rate of procedures to salvage conduits was higher in group B and proved to be more successful in group B, leading to a higher rate of 10.1% salvaged conduits vs 2.5% in group A.

The cumulative patency rate according to type of AVF was similar in the two groups, although there was a slightly better outcome of brachiocephalic AVF in group B, which was not statistically significant. Vascular access performed with a prosthetic graft had a higher cumulative patency rate in group A ($P = .05$; Table V). The creation of brachiocephalic AVFs in the elderly was more successful in our series, showing higher and statistically significant primary ($P < .001$) and cumulative patency ($P = .03$) rates compared with radiocephalic AVFs.

As expected, the number of patients who had died after AVF formation was higher in group A (109 vs 24; $P = .002$). The rate of patients who died with a functioning AVF was similar in the two groups (56% vs 54%). Furthermore, the number of days that the conduit continued to function for was similar in the two groups (516 vs 511 days), as indicated by the Kaplan-Meier curves (Fig).

DISCUSSION

In this study we present one of the largest series evaluating the outcome of conduit creations in elderly patients. These results support the principle that conduit formation is as worthwhile in elderly patients as it is in younger patients receiving HD. A substantial number of studies have been published in the recent past analyzing the outcome of conduit formation in general, but not many have focused on the growing population of elderly requiring HD. Initially, the creation of conduits in the elderly did not have encouraging results, but in the following years, an increasing number of series have strengthened opinion in favor of conduit formation in the elderly.[6,8-14]

The patients included in our study reflect the population encountered in the catchment area of our institution, resembling a higher proportion of elderly white patients and a growing younger population from ethnic minorities. This social background may help to interpret the ethnic differences in the two groups we present and also the differences in diabetes and history of HD.

The liberal use of inclusion and exclusion criteria in many published series makes it rather complicated to define an acceptable cumulative patency rate. Our results are comparable to those already published,[4,10,15-19] considering also that we included the conduits that failed to mature in the study analysis (21% of all causes of failure in group A). Also in our series, the patency rates were higher than the weighted mean patency rates of a recent meta-analysis.[20]

In our practice, we favor radiocephalic AVF as first choice also in the elderly if judged appropriate; the patency rate of radiocephalic AVF in our series was similar in the two groups, and our cumulative patency (CP) rate of 65% at 12 months in the elderly was better than that published in a recent meta-analysis, which showed a CP rate of 54% at 12 months.[20,21] The strategy we use in the elderly is not aimed at attempting a distal AVF at all costs, and we try to offer patients the most potentially successful conduit first.

The principle of saving more proximal veins for later use may not always be rewarding in the elderly. The quality and the size of the veins in the forearm are more commonly inadequate for the creation of a distal AVF. Also, the failure of a distal AVF may expose the elderly patient to the need for percutaneous cannulation of large vessels for emergency HD and may instigate a spiral of long hospital admission potentially associated with an increased risk of lethal complications. Moreover, these patients have a shorter life expectancy, as documented by published series on survival of the elderly after starting HD showing that >50% of patients aged >75 died ≤2 years after starting HD, with a mean survival of 31 months.[22] A different series found that the median survival of octogenarians undergoing HD was 28 months.[23]

Brachiobasilic vein transposition showed good results with high patency rates of 80% in group A and 83% in group B and no difference between the two groups. Similar results were found also in other series.[20,24,25]

Fewer attempts were made to salvage conduits in the elderly group. This can be explained by the higher incidence of conduits that failed to mature, and in our series, this particular subgroup proved to be particularly refractory to any attempted procedure to rescue a primary nonfunctioning AVF. This may suggest that in the case of primary nonfunctioning AVF in the elderly, it may be acceptable to create a new AVF rather than to attempt to rescue the AVF, particularly in an AVF that failed to mature.

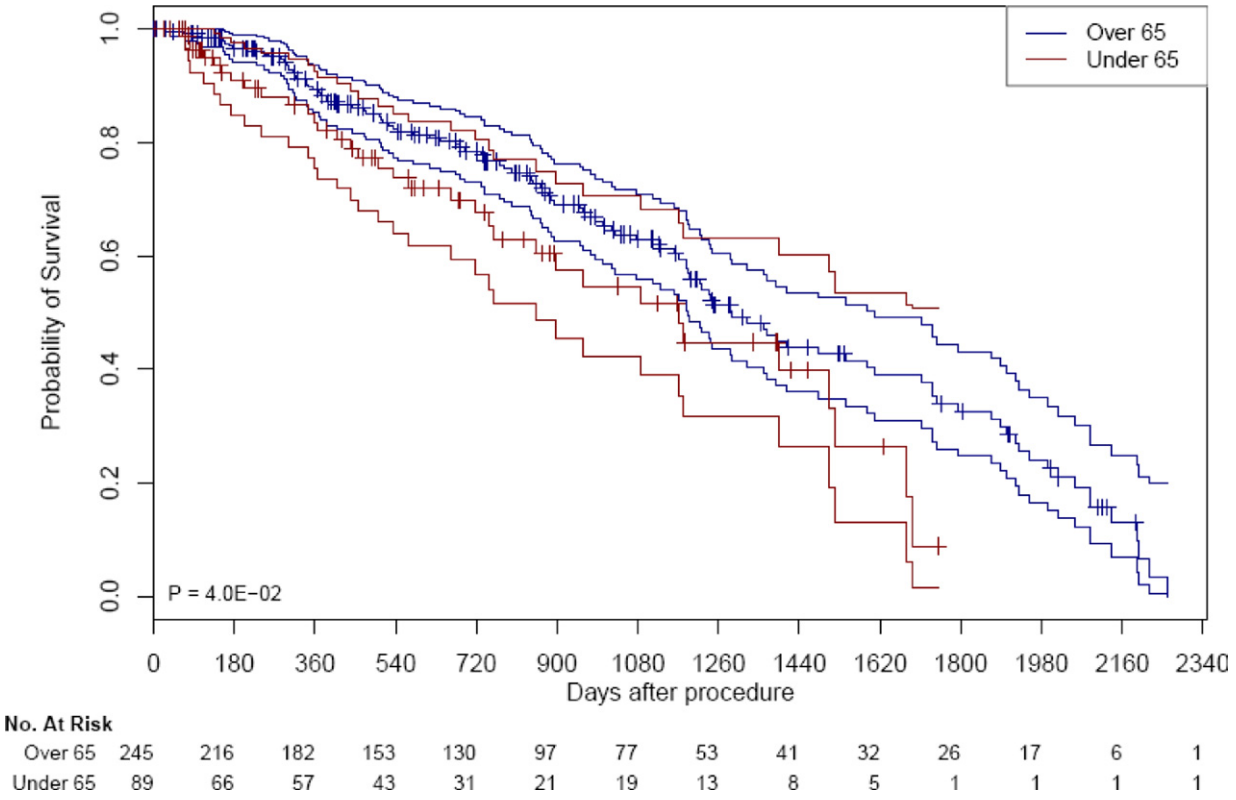

Fig. Kaplan-Meier curves show the survival of all conduits. There are three lines depicted for age ≥65 years (*blue*) and three lines depicted for age <65 years (*red*), with the *lowest line* representing primary patency; the *middle line,* assisted primary patency; and the *highest line,* cumulative patency. The standard error did not exceed 10% at any point in the curve.

In our experience, the creation of a conduit for HD access in the >65 age group was an achievable target with high patency rates; the exclusion of the conduits that failed to mature from our series would raise the CP rate to 78%. However, we believe that this specific complication should always be included in the analysis, particularly in the elderly, being more commonly encountered in this group of patients.

Although we do not use routine radiologic assessment of venous anatomy, we believe that the incidence of failure to mature in the elderly group should encourage the more frequent use of duplex ultrasound assessment of elderly patients to identify potential anatomic anomalies such as stenosis or multiple branches.

Presently, there are no specific guidelines for conduit creation in the elderly. However, the aim should be to create a conduit with the highest chance of success first, independently of its anatomic location.

Patency rates may not be the only outcome measure for success[26] of conduit creation in the elderly. Important parameters such as life expectancy, cost, patient preference, number of revisions needed, and length of time for successful HD should be analyzed in future studies to clarify the best options for a dramatically growing elderly population.

CONCLUSIONS

Excellent patency rates can be achieved after conduit formation in the elderly. Preoperative ultrasound scanning may be valuable to increase maturation rates. Attempts at salvaging conduits in the elderly may be less worthwhile than in younger patients.

AUTHOR CONTRIBUTIONS

Conception and design: RC, NM
Analysis and interpretation: NS, IM, IRM
Data collection: NS, AS, HL
Writing the article: RC, NS, NM
Critical revision of the article: AS, HL, ID, IRM
Final approval of the article: NS, AS, HL, IRM, NM, RC, IM
Statistical analysis: RC, IRM
Obtained funding: Not applicable
Overall responsibility: NS

REFERENCES

1. Akoh JA, Sinha S, Dutta S, Opaluw AS, Lawson H, Shaw JF, et al. A 5 year audit of haemodialysis access. Int J Clin Pract 2005;59:847-51.
2. United States Renal Data System. Annual data report: atlas of end-stage renal dialysis disease in the United States. Bethesda: National Institute of Health, National Institute of Diabetes and Digestive and Kidney Disease; 2003.

3. Kim YO, Choi YJ, Kim JI, Kim YS, Kim BS, Park CW, et al. The impact of intima-media thickness of radial artery on early failure of radiocephalic arteriovenous fistula in hemodialysis patients. J Korean Med Sci 2006;21:284-9.
4. Lok CE, Oliver MJ, Su J, Bhola C, Hannigan N, Jassal SV. Arteriovenous fistula outcomes in the era of the elderly dialysis population. Kidney Intl 2005;67:2462-8.
5. Pisoni RL, Young EW, Dykstra DM, Greenwood RN, Hecking E, et al. Vascular access use in Europe and the United States: results from the DOPPS. Kidney Int 2002;62:305-16.
6. Lin SL, Huang CH, Chen HS, Hsu WA, Yen CJ, Yen TS. Effects of age and diabetes on blood flow rate and primary outcome of newly created hemodialysis arteriovenous fistulas. Am J Nephrol 1998;18:96-100.
7. Sidawy AN, Gray R, Besarab A, Henry M, Ascher E, Silva M Jr, et al. Recommended standards for reports dealing with arteriovenous hemodialysis accesses. J Vasc Surg 2002;35:603-10.
8. Gomez Campdera FJ, Polo JR, Sanabia J, Tejedor A. First choice vascular access in patients over 65 years of age starting dialysis. Nephron 1996;73:342-3.
9. Hinsdale JLG, Hoover E. Vascular access for haemodialysis in the elderly: results and perspectives in a geriatric population. Dial Transplant 1985;14:560-5.
10. Golledge J, Smith CJ, Emery J, Farrington K, Thompson HH. Outcome of primary radiocephalic fistula for haemodialysis. Br J Surg 1999;86:211-6.
11. Brunori G, Verzeletti F, Zubani R, Movilli E, Gaggiotti M, Cancarini G, et al. Which vascular access for chronic hemodialysis in uremic elderly patients? J Vasc Access 2000;1:134-8.
12. Burt CG, Little JA, Mosquera DA. The effect of age on radiocephalic fistula patency. J Vasc Access 2001;2:110-3.
13. Johnson CP. Preoperative and intraoperative predictors of vascular access outcome. In: Henry ML, editor. Vascular access for hemodialysis—VIII. Chicago: W. L. Gore and Assoc and Precept Press; 2002. p. 143-56.
14. Kawecka A, Debska-Slizien A, Prajs J, Krol E, Zdrojewski Z, Przekwas M, et al. Remarks on surgical strategy in creating vascular access for hemodialysis: 18 years of one centers experience. Ann Vasc Surg 2005;19:590-8.
15. Staramos DN, Lazarides MK, Tzilalis VD, Ekonomou CS, Simopoulos CE, Dayantas JN. Patency of autologous and prosthetic arteriovenous fistulas in elderly patients. Eur J Surg 2000;166:777-81.
16. Ravani P, Marcelli D, Malberti F. Vascular access surgery managed by renal physicians. The choice of native arteriovenous fistulas for haemodialysis. Am J Kid Dis 2002;40:1264-76.
17. Fitzgerald JT, Schanzer A, Chin AI, McVicar JP, Perez RV, Troppmann C, et al. Outcome of upper arm arteriovenous fistula for maintenance haemodialysis access. Arch Surg 2004;139:201-8.
18. Rodriquez JA, Armadans L, Ferrer E, Olmos A, Codina S, Bartolomé J, et al. The function of permanent vascular access. Nephrol Dial Transplant 2000;15:402-8.
19. Lok Ce, Oliver MJ. Overcoming barriers to arteriovenous fistula creation and use. Semin Dial 2003;16:189-96.
20. Lazarides MK, Georgiadis GS, Antoniou GA, Staramos DN. A meta-analysis of dialysis access outcome in elderly patients. J Vasc Surg 2007;45:420-6.
21. Rooijens PPG, Tordoir JHM, Stijnen T, Burgmans JPJ, Smet AAE, Yo TI. Radiocephalic wrist arteriovenous fistula for hemodialysis: meta-analysis indicates a high primary failure rate. Eur J Vasc Endovasc Surg 2004;28:583-9.
22. Letourneau I, Ouimet D, Dumont M, Pichette V, Leblanc M. Renal replacement in end-stage renal disease patients over 75 years old. Am J Nephrol 2003;23:71-7.
23. Joly D, Anglicheau D, Alberti C, Nguyen A, Tuam M, Grunfeld J, et al. Octogenarians reaching end-stage renal disease: cohort study of decision-making and clinical outcomes. J Am Soc Nephrol 2003;14:1012-21.
24. Bonforte G, Zerbi S, Pasi A, Sangali L, Rivera R, Surian M. Distal arteriovenous fistulas in elderly hemodialysis patients. J Vasc Access 2000;1:144-7.
25. Dixon BS, Novak L, Fangman J. Hemodialysis vascular access survival: upper-arm native arteriovenous fistula. Am J Kidney Dis 2002;39:92-101.
26. Huber TS, Carter JW, Carter RL, Seeger JM. Patency of autogenous and PTFE upper extremity arteriovenous hemodialysis accesses: a systematic review. J Vasc Surg 2003;38:1005-11.

Submitted Jan 26, 2010; accepted Sep 28, 2010.